

Chapter 7

Evaluating Trade-off Issues

This chapter serves to summarize much of the information presented throughout the CTSA. Section 7.1 presents a summary of the findings, drawing upon the risk information developed in Chapter 3 and the cost analysis developed in Chapter 4. Section 7.2 presents a benefit/cost analysis of using the baseline blanket wash, VM&P naphtha, compared to the substitute blanket washes. Information on costs, exposures and risks are presented here so that an easy comparison can be made between the substitute blanket washes and the baseline.

Section 7.3 provides summary sheets for each blanket wash. These summary sheets contain information on composition, performance, cost, risk, exposure, and regulatory concerns and are intended to provide the reader with a quick reference guide for each blanket wash.

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7.1 FINDINGS

Earlier sections of the CTSA evaluated the risk and performance of the baseline blanket wash as well as the alternatives. This section presents the findings associated with the analysis of blanket washes. Relevant data include: worker health risks, public health risks, flammability risks, ecological risk, energy and natural resource use, VOC content, and labor, materials, and product costs. Each is discussed in turn below.

Worker Health Risks

The majority of substitute formulations, as well as the baseline, present some concern for dermal exposure, driven primarily by high exposure levels estimated in Chapter 3. The dermal exposure estimates provide an upper-bound estimate which no worker is expected to exceed because the exposure assessment assumes that no gloves or barrier creams are used by workers when cleaning a blanket. Worker inhalation risks are very low for nearly all of the blanket wash products due to low or negligible exposure levels. Only one of the substitute formulations (Blanket Wash 3) triggered inhalation concerns. The components of all other substitute products present low or no concern. The baseline presents low inhalation concern. Table 7-1 presents a summary of worker risks beginning with the baseline product, VM&P naphtha. The risk assessment assumed that components of concern present a greater risk than components of low to moderate concern, and components of low to moderate present a greater risk than components of low concern, and so on (no/low concern < low to moderate concern < concern).

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Table 7-1. Summary of Risk Conclusions of Substitute and Baseline Blanket Wash Cleaners

Formula Number	Chemicals Identified as a Concern in the Risk Assessment	Worker Health Risk	
		Dermal	Inhalation
Baseline (28)	Hydrocarbons, petroleum distillates	concern	no/low concern
1	No individual chemicals of concern identified	no/low concern ¹	no/low concern ¹
3	Hydrocarbons, aromatic	concern	no/low concern
	Hydrocarbons, aromatic	concern	concern
	Hydrocarbons, aromatic	concern	no/low concern
4	Terpenes	concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
5	Hydrocarbons, aromatic	concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
	Ethylene glycol ethers	concern	no/low concern
6	Hydrocarbons, petroleum distillates	concern	no/low concern
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
	Fatty acid derivatives	no/low concern ²	no/low concern ²
	Alkyl benzene sulfonates	no/low concern ²	no/low concern ²
7	Terpenes	concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
8	Propylene glycol ethers	no/low concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
9	Ethoxylated nonylphenol	no/low concern	no/low concern ²
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
10	Fatty acid derivatives	no/low concern ¹	no/low concern ²
11	Hydrocarbons, petroleum distillates	concern	no/low concern
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
	Alkyl benzene sulfonates	no/low concern ¹	no/low concern ²
12	Hydrocarbons, petroleum distillates	concern	no/low concern
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹
14	Fatty acid derivatives	no/low concern ¹	no/low concern ²
	Propylene glycol ethers	no/low concern ¹	no/low concern ¹
16	Terpenes	concern	no/low concern

Formula Number	Chemicals Identified as a Concern in the Risk Assessment	Worker Health Risk	
		Dermal	Inhalation
17	Glycols	no/low concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
	Alkali/salts	no/low concern	no/low concern ²
	Fatty acid derivatives	possible concern	no/low concern ²
18	Hydrocarbons, petroleum distillates	concern	no/low concern
	Dibasic esters	concern	no/low concern
	Alkyl benzene sulfonates	no/low concern ¹	no/low concern ¹
	Esters/lactones	no/low concern ¹	no/low concern ¹
19	Propylene glycol ethers	no/low concern ¹	no/low concern ¹
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
20	Hydrocarbons, petroleum distillates	concern	no/low concern
	Alkyl benzene sulfonates	no/low concern ¹	no/low concern ¹
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ¹
21	Hydrocarbons, aromatic	concern	no/low concern
	Hydrocarbons, petroleum distillates	concern	no/low concern
	Fatty acid derivatives	no/low concern ¹	no/low concern ¹
22	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
23	Terpenes	possible concern	no/low concern
	Nitrogen heterocyclics	possible concern	no/low concern
24	Alkyl benzene sulfonates	concern	no/low concern ²
	Terpenes	concern	no/low concern
	Ethylene glycol ethers	possible concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
25	Terpenes	concern	no/low concern
	Esters/lactones	possible concern	no/low concern
26	Esters/lactones	concern	no/low concern ²
	Esters/lactones	no/low concern	no/low concern ²
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
27	Terpenes	concern	no/low concern
29	Fatty acid derivatives	no/low concern ¹	no/low concern ²
30	Hydrocarbons, aromatic	concern	no/low concern
	Propylene glycol ethers	no/low concern ¹	no/low concern ¹
31	Hydrocarbons, aromatic	concern	no/low concern
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹

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Formula Number	Chemicals Identified as a Concern in the Risk Assessment	Worker Health Risk	
		Dermal	Inhalation
32	Hydrocarbons, petroleum distillates	low to moderate concern ¹	low to moderate concern ¹
33	Hydrocarbons, aromatic	concern	no/low concern
	Hydrocarbons, petroleum distillates	concern	no/low concern
	Propylene glycol ethers	no/low concern	no/low concern
34	Terpenes	concern	no/low concern
	Alkoxylated alcohols	no/low concern	no/low concern
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹
35	Hydrocarbons, aromatic	concern	no/low concern
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹
36	Hydrocarbons, petroleum distillates	concern	no/low concern
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
	Propylene glycol ethers	no/low concern	no/low concern
	Fatty acid derivatives	no/low concern ¹	no/low concern ²
37	Hydrocarbons, aromatic	possible concern	no/low concern
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹
	Hydrocarbons, petroleum distillates	low to moderate concern ¹	no/low concern ¹
38	Fatty acid derivatives	no/low concern ¹	no/low concern ²
	Alkoxylated alcohols	no/low concern ¹	no/low concern
	Hydrocarbons, petroleum distillates	low to moderate concern	no/low concern ¹
39	Hydrocarbons, petroleum distillates	concern	no/low concern
	Propylene glycol ethers	no/low concern	no/low concern
	Alkanolamines	concern	no/low concern ²
	Ethylene glycol ethers	possible concerns	no/low concern
40	Hydrocarbons, petroleum distillates	concern	no/low concern
	Ethoxylated nonylphenol	no/low concern	no/low concern ²
	Hydrocarbons, aromatic	moderate concern ¹	no/low concern ²
	Fatty acid derivatives	no/low concern ¹	no/low concern ²

¹ Risks for this chemical in this product could not be quantified; therefore, the level of concern for this chemical is based upon a structure-activity analysis of potential hazard.

² Risks for this chemical in this product could not be quantified; therefore, the level of concern for this chemical is based upon a low risk call based on estimates of no or extremely low exposure.

Public Health Risk

In addition to worker exposure, members of the general public may be exposed to blanket wash chemicals due to their close physical proximity to a printing facility or due to the wide dispersion of chemicals. Individuals in the general public that are exposed to blanket wash chemicals are potentially subject to health risks. The EPA risk assessment identified no concerns for the general public through ambient air, drinking water, or fish ingestion due to use of blanket washes under the small shop scenario used here. Using the model facility approach, the general population exposure assessment predicted that exposure levels would be extremely low for all media examined. Because of the low exposure levels, no concerns were identified for the general public from the use of blanket wash chemicals.

Flammability Risk

Some blanket wash chemicals in this assessment present risks of fire and explosion because of their flammability and high volatility. In order to assess the relative fire hazard of the substitute and baseline blanket washes, the flash points of each product is compared to OSHA and EPA definitions of flammable liquids.^a Flammable liquids are defined by OSHA as having a flash point less than 141°F. Similarly, EPA defines RCRA ignitable wastes (40 CFR 261.21) as having a flash point of 140°F or less. Table 7-2 presents the flash points of the baseline as well as the alternative blanket washes. Flash points were developed as part of the performance demonstration.

Table 7-2. Relative Flammability Risk of Substitute and Baseline Blanket Washes

Blanket Wash	Flash Point (°F)	Blanket Wash	Flash Point (°F)
<i>Baseline (28)</i>	50	22	157+
1	230+	23	140
3	114	24	100
4	114	25	220+
5	139	26	230+
6	152	27	145
7	165	29	230+
8	115	30	100+
9	230+	31	105
10	230+	32	220
11	150	33	105
12	125	34	138
14	230+	35	105
16	145	36	175

^aFlash point is defined as the lowest temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

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Blanket Wash	Flash Point (°F)	Blanket Wash	Flash Point (°F)
17	220+	37	82
18	150	38	230+
19	230+	39	155
20	170	40	155
21	115		

Ecological Risk

The EPA risk assessment evaluated the ecological risks of the substitute products as well as the baseline blanket wash; in the analysis for this CTSA, only the risks to aquatic species were considered. Evaluation of aquatic risks involved comparing a predicted ambient water concentration to a “concern concentration” for chronic exposures to aquatic species using a hypothetical receiving stream (a relatively small stream at low flow conditions). The concern concentration is expressed in mg/L water. Exposure concentrations below the concern concentration are assumed to present low risk to aquatic species. Exposures that exceed the concern concentration indicate a potential for adverse impact on aquatic species. Two chemicals contained in the blanket wash formulations may present risks to aquatic organisms. The two chemicals were alkyl benzene sulfonates, present in Formulations 3, 4, 6, 8, 11, 18, and 20, and ethoxylated nonylphenols, present in Formulations 4, 5, 7, 8, 9, 17, 24, and 40. Risks to plants (other than aquatic algae) and wildlife were not examined. Switching to these substitutes would likely increase aquatic risks rather than decrease them. The baseline product was not identified as creating an aquatic species risk.

Energy and Natural Resource Use

As described in Chapter 5, the life cycle of any product begins with the extraction of raw materials from the environment, and continues through the manufacture, transportation, use, recycle, and disposal of the product. Decisions at each stage of a product’s life will impact its energy and natural resource demand. Section 5.1, Energy and Natural Resource Issues, presents a discussion describing the issues to consider when cleaning the blanket and purchasing blanket washes but does not analyze the individual energy and natural resource requirements of the substitute and baseline washes due to various data limitations. The issues discussed include: 1) optimization of the washing technique to reduce blanket wash use, press wipe use, and waste print runs; 2) derivation of blanket wash products from non-renewable (petroleum and natural gas) and renewable (plant products) chemical raw materials (it is not clear, however, which raw materials demand the least energy and natural resources without a full life-cycle analysis); 3) lack of differentiation between products in terms of energy consumption during the product formulation process because the same basic processes are used to formulate all blanket wash products; and 4) reduction in packaging requirements and transportation/distribution energy consumption due to the use of concentrated formulations, assuming the products are diluted by the printer. A thorough quantitative evaluation of each life-cycle stage was beyond the scope of the CTSA.

Volatile Organic Compound (VOC) Releases

As described in Chapter 4, the volatile organic compound (VOC) content of the alternative and the baseline blanket washes was independently tested by the GATF laboratory

in Pittsburgh, Pennsylvania. VOCs are currently regulated under clean air legislation occupational exposure rules and toxics use and release reporting laws; therefore, substitution of high VOC cleaners has the potential to reduce the regulatory burden for printers. Table 7-3 presents a summary of the relative VOC content of the baseline and alternative blanket washes.

Table 7-3. VOC Content of the Substitute and Baseline Blanket Washes

Blanket Wash	VOC Content (lbs/gal;% by weight)	Blanket Wash	VOC Content (lbs/gal;% by weight)
Baseline (28)	6.2; 100%	22	Not measured; 2.17%
1	2.3; 30%	23	0.48; 6%
3	6.4; 91%	24	1.5; 19%
4	6.4; 89%	25	4.1; 55%
5	2.5; 30%	26	1.3; 18%
6	3.5; 47%	27	7.2; 93%
7	3.0; 36%	29	2.1; 30%
8	3.3; 41%	30	0.48; 7%
9	0.11; 10%	31	6.6; 99%
10	0.16; 2%	32	6.5; 99%
11	4.3; 61%	33	3.4; 46%
12	1.3; 20%	34	2.8; 39%
14	0.97; 12%	35	6.7; 99%
16	7.2; 99%	36	3.5; 48%
17	0.051; 0.6%	37	1.0; 14%
18	4.4; 60%	38	4.9; 65%
19	1.8; 22%	39	2.9; 37%
20	2.7; 35%	40	3.8; 52%
21	3.5; 47%		

Performance

The performance of each of the substitute blanket washes as well as the baseline was demonstrated using both laboratory and production run tests. The laboratory tests determined the flash point, VOC content, and pH and demonstrated the blanket swell and wipability of each product. The production run tests, conducted at two facilities for each of the substitute products and at all facilities for the baseline, collected information such as quantity of wash

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used, time spent to wash the blanket, ink coverage, and the effectiveness of the wash. Summary results are presented in Table 7-4. The widely variable conditions between and within printing facilities and the short duration of the production runs used for the performance demonstrations does not allow the results to be interpreted as definitive performance assessments of the blanket washes.

Table 7-4. Blanket Wash Laboratory Test Results

Form. No.	Flash Point (°F)	VOC Content ¹ (lbs/gal; % by weight)	pH	Blanket Swell		Wet Ink Film Strokes	Dry Ink Film Strokes
				1 hr (%)	5 hr (%)		
1	230+	2.3; 30%	7.8*	1.5	3.0	4	6
3	114	6.4; 91%	3.4*	1.5	4.5	4	4
4	114	6.4; 89%	8.7	3.0	5.2	3	2
5	139	2.5; 30%	4.3	6.1	15.4	9	8
6	152	3.5; 47%	5.5	0.7	1.5	8	6
7	165	3.0; 36%	9.3	3.8	6.8	6	8
8	115	3.3; 41%	4.0	7.7	20	7	9
9	230+	0.77; 10%	4.6	1.5	1.5	19	30
10	230+	0.16; 2%	5.7	0.7	0.7	12	13
11	150	4.3; 61%	5.0*	0.0	1.5	4	5
12	125	1.3; 20%	8.2	0.0	1.5	7	11
14	230+	0.97; 12%	5.0	1.5	3.0	8	10
16	145	7.2; 99%	9.8	4.5	10.6	2	2
17	220+	0.051; 0.6%	9.8	1.5	1.5	100	100
18	150	4.4; 60%	5.5	1.5	4.5	8	7
19	230+	1.8; 22%	4.6	1.5	1.5	11	9
20	170	2.7; 35%	7.1	0.0	1.5	5	7
21	115	3.5; 47%	6.2	0.0	1.5	7	6
22	157(a)	NM; 2.17% ²	7.4(c)	1.5	1.5	13	13
23	140	0.48; 6%	9.2	0.0	1.5	24	100
24	100	1.5; 19%	9.9	1.5	3.0	15	12
25	220+	4.1; 55%	4.3	3.0	4.5	22	32
26	230+	1.3; 18%	7.8*	0.0	0.0	6	14
27	145	7.2; 93%	3.9	3.0	4.5	3	3
28	50	6.2; 100%	6.6	1.5	3.0	3	8
29	230+	2.1; 30%	7.2	1.5	1.5	9	18
30	100(a)	0.48; 7%	7.6(c)	0.7	1.5	5	11

Form. No.	Flash Point (°F)	VOC Content ¹ (lbs/gal; % by weight)	pH	Blanket Swell		Wet Ink Film Strokes	Dry Ink Film Strokes
				1 hr (%)	5 hr (%)		
31	105	6.6; 99%	7.6	1.5	3.0	3	3
32	220	6.5; 99%	8.5	0.1	1.5	5	30
33	105	3.4; 46%	7.2*	4.5	7.6	4	4
34	138	2.8; 39%	6.6	1.5	3.0	10	20
35	105	6.7; 99%	6.0	1.5	6.1	3	5
36	175	3.5; 48%	5.7*	0.7	1.5	4	5
37	82	1.0; 14%	3.9	3.0	3.0	5	8
38	230+	4.9; 65%	5.6	0.0	1.5	9	16
39	155	2.9; 37%	9.2	1.5	3.0	7	10
40	155	3.8; 52%	4.8	1.5	3.0	5	10
(a) full strength (c) 25% NC - not calculated NM - not measured * - pH fluctuates wildly							

¹VOC content in lbs/gal was measured at GATF; % by weight VOC was calculated based on information submitted by the manufacturer.

²VOC content in lbs/gal was not measurable; % by weight VOC was submitted by the manufacturer.

Prior to testing the blanket washes in a print shop, the 36 substitute blanket washes were tested in the laboratory for blanket swell potential and wipability. Of the 36 washes, 22 were deemed to be satisfactory for demonstrations at volunteer printing shops (two shops demonstrated each blanket wash). The results of the performance demonstrations were highly variable between the two print shops using a particular blanket wash and among the many blanket washes themselves. Performance varied to a great extent based on the amount of ink coverage. Excluding trials with heavy ink coverage, eleven washes gave good or fair performances at both facilities, seven washes gave good or fair performance at one facility but not the other, and the remaining four washes performed poorly at both facilities.

Labor, Materials, and Product Costs

The costs of using each of the substitute blanket washes as well as the baseline depend on variations in labor costs, product use, and material and equipment use at each facility that participated in the performance demonstrations. Each substitute blanket wash product was tested by two facilities. The baseline product was tested by all facilities. Costs for each product are presented on a per wash basis, a per press basis, and a cost per press/shift/year basis. In comparing the cost data for the substitute and the baseline products, the costs of using the substitute blanket cleaners exceed the cost of using the baseline product in nearly all cases. In some cases smaller quantities of wash or less cleaning time was required, resulting in a cost savings when using the substitute instead of the baseline wash. Blanket Washes 26, 32, 37, and 40 resulted in costs savings relative to the baseline product. Overall, however, the costs of using the substitute blanket washes exceed the costs of using the baseline wash in the large majority of cases. Costs associated with using the substitute blanket washes range from a low

of \$1.72 to a high of \$8.80 per press.^b Costs of using the baseline product range from \$1.64 to \$3.64 per press. Where costs of the alternative blanket washes exceed the baseline, percentage cost increases range from one percent to 179 percent. Table 7-5 presents a summary of the cost comparisons.

Disposal costs were not considered in this cost comparison because all but one of the printers participating in the performance demonstrations use cloth wipes that are leased from an industrial laundry. Many industrial laundries currently do not distinguish between hazardous and nonhazardous blanket washes when laundering wipes; therefore, it was assumed that there would be no savings in waste handling or processing costs associated with switching to a substitute blanket wash product.

7.2 QUALITATIVE DISCUSSION OF BENEFIT/COST ANALYSIS

7.2.1 Introduction

Social benefit/cost analysis is a tool used by policy makers to systematically evaluate the impacts to all of *society* resulting from individual decisions. The decision evaluated in this analysis is the choice of a blanket wash product. Printers have certain criteria which they use to evaluate the benefits and costs of alternative blanket cleaners such as price, drying time, flexibility of use for rollers and blankets, propensity to cause blanket swell, etc. A printer might ask what impact their choice of blanket washes will have on operating costs, compliance costs, liability costs, and insurance premiums. This business planning process is unlike social benefit/cost analysis, however, because it approaches the comparison from the standpoint of the individual printing firm and not from the standpoint of *society*. A social benefit/cost analysis seeks to compare the benefits and costs of a given action, considering both the private and external costs and benefits.^c Therefore, the analysis will consider the impact of the alternative blanket cleaners on operating costs, regulatory costs, and insurance premiums, but will also consider the *external* costs and benefits of the alternative blanket cleaners such as reductions in environmental damage and reductions in the risk of illness for the general public. External costs are not borne by the printer, however; they are true costs to society.

Benefits of the substitute blanket cleaners may include private benefits such as increased profits resulting from improved worker productivity, a reduction in employee sickness, or reduced property and health insurance costs and external benefits such as a reduction in pollutants emitted to the environment or reduced use of natural resources. Costs of the substitute blanket cleaners may include private costs such as higher operating expenses resulting from a higher priced blanket wash and external costs such as an increase in human health risks and ecological damage. Several of the benefit categories considered in this analysis share elements of both private and external costs and benefits. For example, use of the substitute blanket washes may result in energy and natural resource savings. Such a

^b Presses are assumed to have four units; therefore, four blankets are washed each time a press is cleaned.

^c Private costs include any direct costs incurred by the decision-maker and are typically reflected in the firm's balance sheet. In contrast, external costs are incurred by parties other than the primary participants to the transaction. Economists distinguish between private and external costs because each will affect the decision maker differently. Although external costs are real costs to some members of society, they are not incurred by the decision maker and firms do not normally take them into account when making their decisions. A common example of external costs is the electric utility whose emissions are reducing crop yields for the farmer operating downwind. The external costs incurred by the farmer in the form of reduced crop yields are not considered by the utility when deciding how much electricity to produce. The farmer's losses do not appear on the utility's balance sheet.